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# *Cotula australis* Hook.f. (Asteraceae), a species newly introduced in Morocco

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**Abstract.** We report the discovery of *Cotula australis* Hook.f. for the first time in Morocco and North Africa. We found it living in the cork-oak forest of Maamora (Northwest). This species, a member of the family Asteraceae, is introduced to Morocco and has potential to be highly invasive and destructive to the native environment. We describe the distinctive taxonomic and morphological characters of this species and provide notes on its distribution, ecology, and habitat.

**Keywords.** Cork-oak forest, exotic flora, invasive, Maamora, morphology, North Africa, taxonomy

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## Introduction

In one of the largest cork-oak forests in Morocco, we collected a small species of Asteraceae, which was determined to belong to the genus *Cotula* L. based on the following morphological characters: villous, alternate pennate leaves, flowers carried on persistent pedicels after the fall of the fruits and flower heads of 2–6 mm in diameter. According to IPNI (2023) and POWO (2023), the genus *Cotula*, which is native to Africa, includes 54 species. However, although there are two species of *Cotula* known from Morocco, the identification of our specimen was not possible using the local floristic literature (Fennane et al. 2014) and floras of neighbouring countries (Algeria: Quézel and Santa 1962–1963; Mauritania: Barry and Celles 1991). The only two *Cotula* species known from Morocco, *C. anthemoides* L. and *C. coronopifolia* L., are both alien. There are other species belonging to other genera and sometimes placed in the genus *Cotula*; these are *Matricaria aurea* (Loefl.) Sch. Bip. (≡ *Cotula aurea* Loefl. ≡ *Chamomilla aurea* (Loefl.) Coss. and Kralik.), whose involucral bracts are obovate or panduriform, with broad, black-scarlet margins and large achenes; *Brocchia cinerea* (Delile) Vis. (≡ *Cotula cinerea* Delile), which is large with leaves entire; and *Aaronsohnia pubescens* (Desf.) Bremer & Humphries (≡ *Cotula pubescens* Desf. ≡ *Matricaria pubescens* (Desf.) Sch. Bip. ≡ *Otoglyphis pubescens* (Desf.) Pomel), which is characterized by its odour, tubular flowers, and yellowish achenes (Fennane et al. 2014). Our review of appropriate literature, such as Tutin et al. (1980), Benedí et al. (2019), and ABRS (2015) shows that our specimens are *C. australis* Hook.f. This species has not been reported before from Morocco (see Dobignard and Châtelain 2011; Fennane et al. 2014).

Here, we describe and illustrate *C. australis* for the first time from Morocco. We include notes on the currently known geographical distribution and ecology of this introduced species in Morocco.

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## Methods

As part of a botanical doctoral study in May 2021, we chose the Mamoura cork-oak forest in north-west Morocco to prepare a new floristic checklist for this forest and compare it with those of Sauvage (1961) and Aafi et al. 2005. Our floristic investigations covered all cantons of the forest. The Maamora subaerial forest, which occupies 60,000 ha (Laaribya 2006), is located on the Moroccan Atlantic coast between Salé and Kénitra in the province of Khémisset. The forest extends north to south for 40 km and east to west for 70 km (Fig. 1). This forest environment is characterized by relatively uniform rainfall throughout the year. It receives approximately 350–650 mm/year according to statistics for the period 1980–2013 (Mounir 2016) but currently with less rainfall due to the succession of drought years (Infoclimat 2023); the amount of rainfall decreases from west to east. The coldest month of the year, January, varies between 4.5 °C in the interior areas of the sub-zero zone and 8.5 °C near the coast (Mounir 2016); however, the temperature is currently colder than usual (Infoclimat 2023). The hottest months of the year, July and August, are characterized by a high average maximum temperature in the interior, at 37.1 °C, and a more moderate temperature on the coast, at 27.3 °C (Mounir 2016), but the data shows that these average temperatures are also on the rise (Infoclimat 2023). The bioclimate of the Maamora is semi-arid, with temperate winters in its eastern part and subhumid, warm winters in the western part (Aafi 2007). Generally, the soils of this forest are composed of relatively recent sedimentary deposits that are located on a Palaeozoic substratum (Nafaa 1997; Zouhri et al. 2001, cited by Aroui-Boukbida et al. 2016). The sediments are successively Miocene marl formations constituting the floor of the aquifer, Pliocene to Quaternary sandstones and calcareous sands, and also a formation of the Villafranchian period, which extends from the Pliocene to the Pleistocene and consists of red sandy clay (Nafaa 1997; Zouhri et al. 2001, cited by Aroui–Boukbida et al. 2016). The thickness of this pedological layer is varies greatly and can reach up to 20 m. The characteristics of this soil differ from one canton to another (Nafaa 1997; Zouhri et al. 2001, cited by Aroui–Boukbida et al. 2016).

The vegetation cover of the Maamora is diverse as a result of edaphic, geomorphological, and climatic factors, which vary from one canton to another and within the cantons studied. In this context, the environmental conditions seem favourable to the propagation of *Cotula australis*. Our specimens of this species collected in the Maamora cork-oak forest, were encountered at 11 stations spread over three cantons—three sites in canton A, five in canton B, and three in canton C (Table 1). Our fieldwork was carried out in different seasons from 2020 to 2023, just after rainfall.

We initially identified our specimens as *C. australis* identified using Fennane et al. (2014) and Pl@ntNet (2022). The final determination was confirmed at the Scientific Institute, Mohammed V University of Rabat, using sources that include Tutin et al. (1980), ABRS (2015), and Benedí et al. (2019), in addition to botanical databases and virtual herbariums: PlantList (2023), IPNI (2023), Jstor (2022), SEINet (2023) and GBIF (2022).

During our field investigations, we inventoried species associated with *C. australis* and recorded the habitat and the geographical coordinates of the stations. Voucher specimens were deposited in the National Herbarium of the Scientific Institute of Rabat (RAB), Mohammed V University of Rabat under the code M. IBN TATTOU & O. BENKHNIGUE (RAB 114113) (Fig. 2). For this species, we use the accepted name used in the WFO (2022) and IPNI (2023) databases.

We collected 50 samples of *C. australis*: 20 specimens were transferred to pots in the Plant, Animal and Agro-industry Production laboratory under

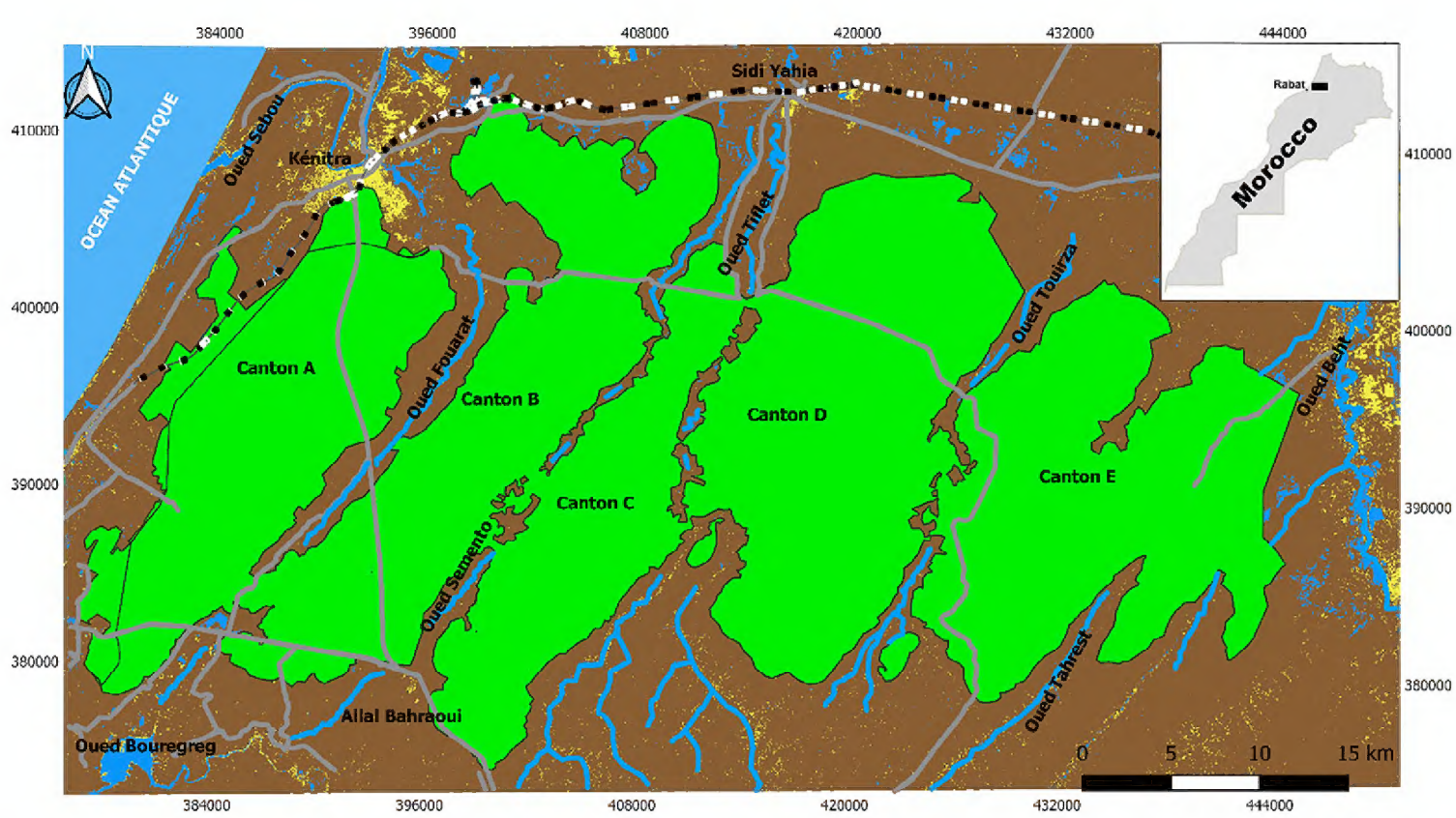


**Figure 1.** Maamora Forest and its cantons A, B, C, D, and E. Green areas = cantons. Blue lines = water. Black and white line = national road (CRF 2019 in Chouin 2019)

**Figure 2.** Exciccata of Herbarium (RAB 114113) of *Cotula australis* Hook.f.

environmental conditions identical to those where the species was found, and 30 individuals were marked to follow them in situ, in order to describe the species at all life stages. *Cotula australis* was collected from Station 2 and observed in the stations shown in Table 1. We obtained an authorization from Ibn Tofail University as well as a pedagogical framework for this research, and permission from the local authorities to collect all our specimens within a legal framework. All samples were provided to the Scientific Institute for verification and registration in the national herbarium.

## Results

***Cotula australis* Hook.f.** in Bot. Antarct. Vol. II. (Fl. Nov.-Zel.). 1: 128 (Hooker 1852).

≡ *Anacyclus australis* Sieber ex Spreng. (Natural History

Museum, Vienna – Herbarium W) Type: Australia. Available at GBIF (2022: https://www.gbif.org/fr/species/8542672).

Figures 2–4

**New records.** MOROCCO – **Kénitra** • cork-oak forest of Maamora in canton A, 300 m from the university street; 34°14.40′N, 006°34.94′W; alt. 81 m a.s.l.; 27.XI.2022; A. Jbilou leg.; 7 spec., RAB114113.

**Morphology** (Figs. 3, 4). Because of its small size, not exceeding 10 cm (Fig. 3A, B), *C. australis* may go unnoticed in the field, especially when plants are individually isolated, but on the other hand, small populations attract attention. It is an annual plant whose life cycle is very short, from 3 to 6 weeks according to our observations. Its stem is very hairy, with antrorsal to spreading hairs (Fig. 3F). The leaves are pennate, 1.5–4.0 cm × 0.8–1.2 cm, 1(2) veined, and hairy (Fig. 3D). The flower head, measuring 2.5–8.0 mm in diameter (Fig. 3C), is borne by a peduncle 3–5 cm long and not exceeding 0.6 mm wide. The peduncle has scattered, antrorsal, appressed to divergent hairs which are shorter than hairs elsewhere on the plant (Fig. 3B). Involucre bracts number 10–20 and have an oblong blade, obtuse apex; they are almost obovate in shape, uni-nervate, with the entire margin membranous, and 1.5–2.0 mm long (Fig. 3E). Marginal flowers (Fig. 3C) are female, apetalous, numerous, positioned in 1–3 whorls, 1 mm long, and positioned above pedicels of 0.8–1.0 mm long in the fruiting state (Fig. 4E). The central florets, faintly yellow to white, are hermaphroditic (Fig. 4B) and number 20–30 (Fig. 4C); they are borne on almost globose pedicels (Fig. 4E), longer than wide, and the corolla is 0.4 mm long and 0.1 (0.2) mm wide and sometimes bears 2(3) entities of subglandular trichomes (Fig. 4B). The achenes of the marginal flowers are brown with a light-brown, winged margin (Fig. 4C), 1–1.2 × 0.4 mm, and with two papillose faces (Fig. 4D). The upper surfaces of the achenes have relatively narrower hairs than hairs on the lower surfaces and with fleshy wings narrower than those on the face (Fig. 4D). The achenes of the central florets are glabrous, 0.8–1.0 mm long, with oblong lower surfaces and almost glossy brown upper surfaces (Fig. 4C). The root system is simple, oblique, with a main root of 2.5–3.0 cm long and 6–10 secondary roots of 1 cm long which bear horizontal extensions. According to our observations, *C. australis* begins flowering in late November and continues until late May. Fructification begins about 5 days after the bloom. The period of bloom varies according to the amount of rainfall and the seasons.

**Distribution and habitat.** *Cotula australis* is native to Oceania and southern Africa and natively occurs in New Zealand, Australia, Madagascar, and South Africa. It has been reported as a weed with very high rates of growth and spread in south-western Europe (Verloove 2015), and it has also been introduced into

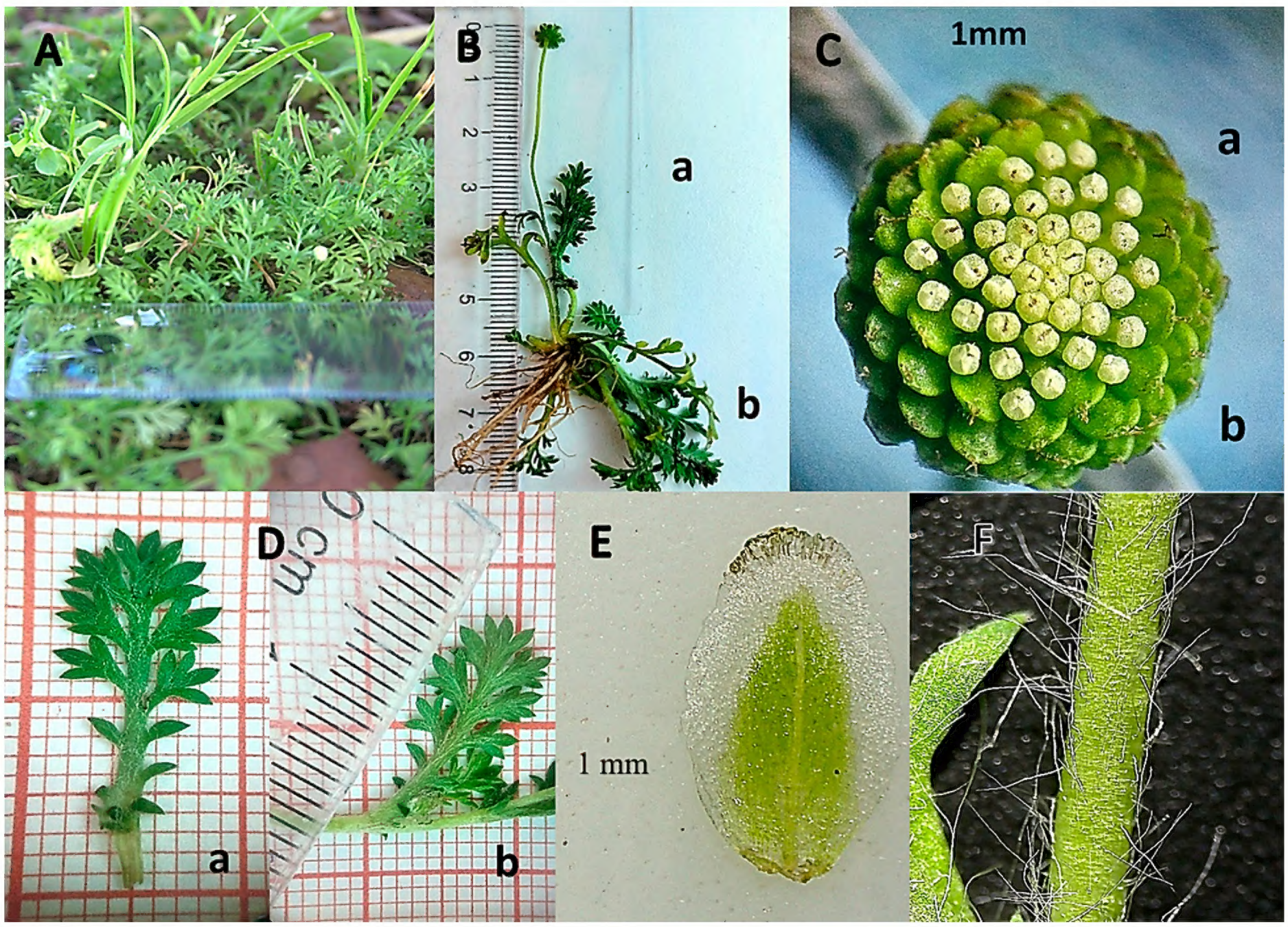


**Figure 3.** *Cotula australis*: General appearance. **A.** In-situ. **B.** Whole plant: (**a**) aerial part; (**b**) roots. **C.** Flower head: (**a**) bisexual central florets; (**b**) female marginal flowers. **D.** Leaves: (**a**) upper side; (**b**) lower side. **E.** Involucre bract. **F.** Hairs.

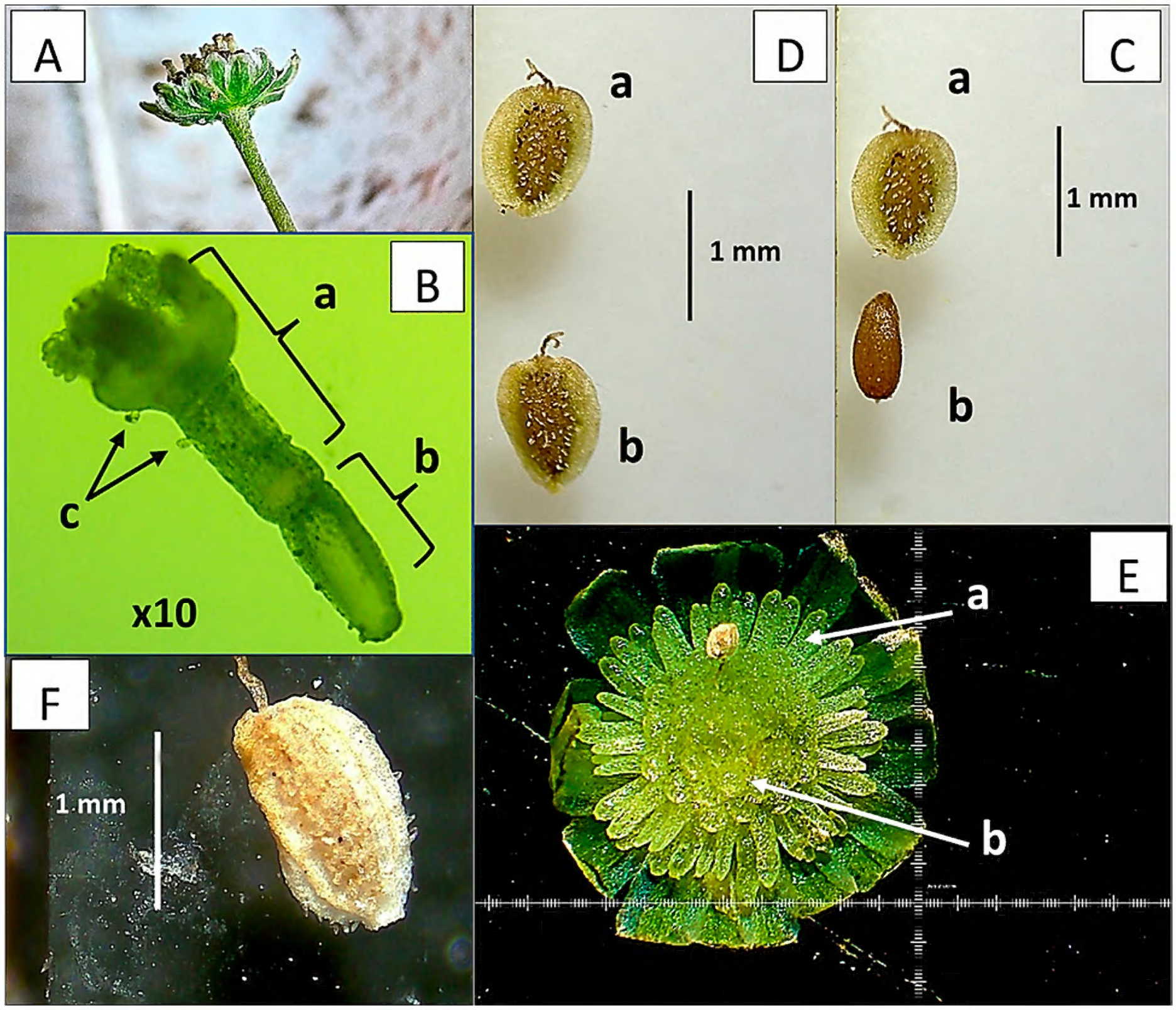


**Figure 4.** *Cotula australis*: Reproductive system. **A.** Pedunculate capitulum. **B.** Central floret: (**a**) corolla; (**b**) carpel; (**c**) subglandular trichomes. **C.** Achenes: (**a**) marginal achene; (**b**) central achene. **D.** Marginal achene (**a**) ventral side; (**b**) dorsal side. **E.** Pedicels: (**a**) marginal; (**b**) central. **F.** Aborted marginal achene.

**Table 1.** *Cotula australis* collection and observation sites

| Canton | Sites | Latitude, longitude | Sampling date | Specimen or observation |
|---|---|---|---|---|
| A | S1 | 34°09.61'N, 006°35.21'W | 27.V.2021 | Obs. |
| | S2 | 34°14.40'N, 006°34.94'W | 27.XI.2022 | RAB 114113, Abdelilah J. leg. |
| | S3 | 34°14.09'N, 006°34.58'W | 29.I.2023 | Obs. |
| B | S4 | 34°14.29'N, 006°25.60'W | 22.III.2022 | Obs. |
| | S5 | 34°12.56'N, 006°26.42'W | 21.IV.2022 | Obs. |
| | S6 | 34°11.99'N, 006°26.88'W | 21.IV.2022 | Obs. |
| | S7 | 34°03.90'N, 006°33.15'W | 29.I.2023 | Obs. |
| | S8 | 34°04.76'N, 006°34.24'W | 29.I.2023 | Obs. |
| D | S9 | 34°15.10'N, 006°11.28'W | 06.IV.2021 | Obs. |
| | S10 | 34°14.97'N, 006°11.25'W | 06.IV.2021 | Obs. |
| | S11 | 34°14.67'N, 006°11.48'W | 08.IV.2021 | Obs. |

south-western North America, north-western South America, and Asia (Fig. 5). This species has not been previously reported from North Africa (Maire 1958; Dobignard and Châtelain 2011; Fennane et al. 2014; IPNI 2023; POWO 2023). Its habitat is often linked to urban green spaces, open wetlands, parks, lawns, and turf (Vibrans 2009; Shabbir and Mujahid 2017), especially grassy parks, but it also occurs on roadsides and

environments characterized by shade and high humidity (Jung et al. 2009) and occurs in oak and pine forests at altitudes up to 2400 m a.s.l. (Vibrans 2009).

In Morrocco, populations of *C. australis* at our sampling sites fluctuate between 2 $m^2$ and 1000 $m^2$, with individuals numbering 420–8000. We found *C. australis* in the cantons (A, B, and D) of the Maamora cork-oak forest (Table 1; Fig. 1), and plants were observed from November to May in 2020–2023. The populations at the three sites (S2, S3, and S7) are all occur along tracks walked by humans and grazing paths of sheep, cattle, and goats.

Other taxa of plants occur near *C. australis*; the following taxa are most common:

- *Acacia mearnsii* De Wild.: RAB114174/AJ.37 02.XII.2022
- *Arisarum vulgare* O.Targ.Tozz.: RAB114183/AJ.45 05.XII.2022
- *Cerastium glomeratum* Thuill.: RAB114177/AJ.38 02.XII.2022
- *Chamaerops humilis* L.: RAB114181/AJ.42 02.XII.2022
- *Filago pygmaea* L.: RAB114176/AJ.37 02.XII.2022
- *Myosotis discolor* Pers.: RAB114180/AJ.43 02.XII.2022
- *Ornithopus sativus* Brot.: RAB114179/AJ.47 02.XII.2022
- *Plantago coronopus* L.: RAB114182/AJ.46 05.XII.2022
- *Quercus suber* L.: RAB114173/AJ.39 02.XII.2022
- *Rumex bucephalophorus* subsp. *gallicus* (Steinh.) Rech.f.: RAB114184/AJ.44 05.XII.2022
- *Thymelaea lythroides* Barratte & Murb.: RAB114175/AJ.41 02.XII.2022
- *Tuberaria guttata* (L.) Fourr.: RAB114178/AJ.40 02.XII.2022

We encountered *C. australis* mainly on modal leached soils, on acidic clayey sand, on marmorized sandy clay (Heusch and Billaux 1966 cited by Bagaram, 2014); and on hydromorphic leached soils at pseudogley depth (Heusch and Billaux 1966 cited by Bagaram, 2014). Sites where *C. australis* populations were encountered range from 81 to 197 a.s.l.

Based on growth monitoring of the 50 samples studied, we noted that one plant of *C. australis* can yield 5–15 inflorescence axes. Each flower head can produce 50–90 seeds, of which 23–41 are achenes produced by the central florets; the rest are marginal fruits. The abortion rate (Fig. 3F) in the central ones was almost zero, while it was 10–30% in the marginal achenes. Indeed, an individual can produce 205–1275 achenes, depending on two main factors. The first factor is to the amount of shade received. The largest and most fertile stands are in areas more sheltered by a high density of phanerophytes and nanophanerophytes having a high crown cover that provides shade; this creates a cool and humid microclimate that is favourable for *C. australia*. The second factor is the soil type; populations on modal leached soils, acidic clay sands, or marmorized sandy clays are significantly more robust in their growth.

## Discussion

*Cotula australis* is an invasive species, pest, and weed (Vibrans 2009; Verloove 2015). Its introduction in Morocco may be due to the importation of annual crop seed, such as wheat or corn, or agricultural or industrial products, such as in Pakistan (Shabbir and Mujahid 2017). At two of our sites (S1 and S3; Table 1), populations of *C. australis* are extensive, confirming this species as invasive in Morocco. Indeed, following several visits to our sites, the spread of the species has been

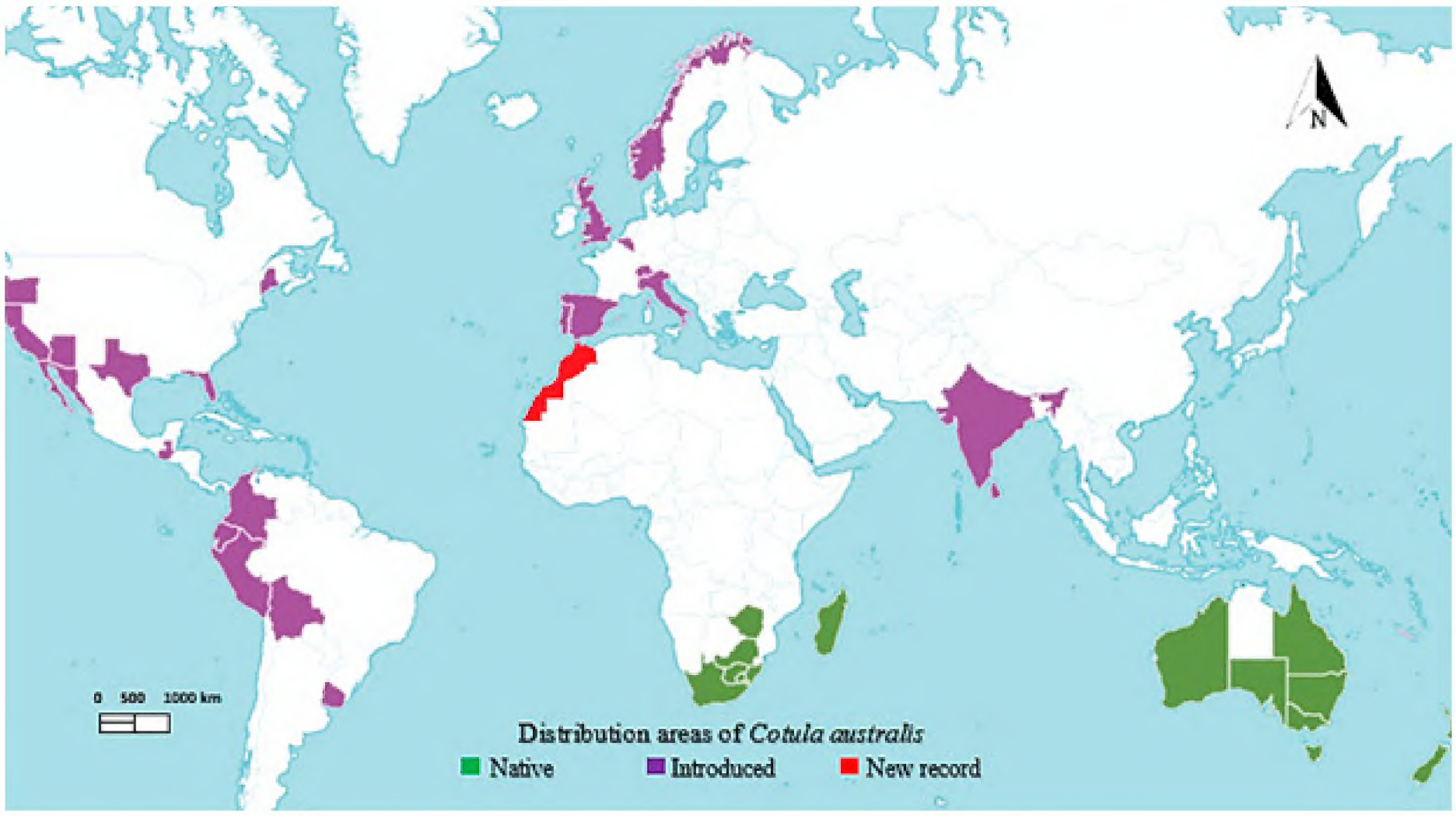


**Figure 5.** General distribution areas of *Cotula australis* around the world (modified from POWO 2023).

found to be progressive and relatively rapid. Our fieldwork to update the flora of the Maamora cork-oak forest has found that the floristic composition of this forest seems to be responding to anthropic change, and we have observed that the plant community is becoming increasingly rich in ruderal and weed species, including *C. australis*.

The discovery of this species in the Maamora cork-oak forest opens perspectives to scientific studies, such as: biogeography, ecology, genetic, etc.

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## Author Contributions

Investigations: JA, NB, HE, JD, OB. Supervision: NB, OB. Visualization: NB, JD, OB. Methodology: JA. Validation: JA, ZL, NB, JD, OB. Visualization: JA. Writing – original draft: JA. Data curation: JA, OB, NB. Writing – review and editing: JA, OB, NB.

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